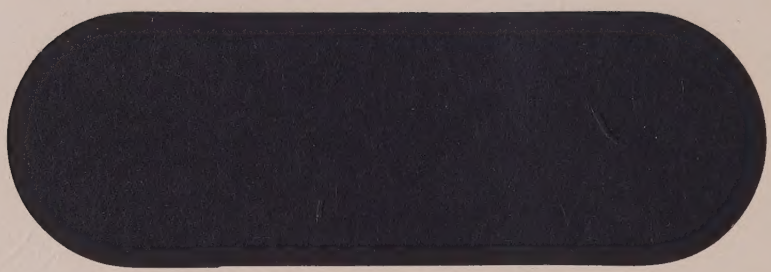
6B14

Rutherford

ELECTRONICS CO.

MODEL B-2 PULSE GENERATOR

SERIAL NUMBER ___



INSTRUCTION MANUAL

MODEL B-2 PULSE GENERATOR

SERIAL NUMBER ___

RUTHERFORD ELECTRONICS CO.
3707 SOUTH ROBERTSON BOULEVARD
CULVER CITY, CALIFORNIA

B-2A PULSE GENERATOR

GENERAL DESCRIPTION

The RUTHERFORD MODEL B-2 PULSE GENERATOR is a general purpose, precision instrument whose function is to produce synchronizing pulses at various times relative to one another, and to produce a main pulse over which one has very fine control of repetition rate, delay, pulse width, and amplitude. Further, our MODEL B-2 PULSE GENERATOR pboduces this pulse with good rise and fall times, a flat top at low impedance - and - with good resolution.

These desirable features result from the use of precision and quality components wherever necessary to insure peak performance.

SPECIFICATIONS

INTERNAL OSCILLATOR

Ranges -	X100	100 KC	to	10 KC
	X10	10 KC	to	1 KC
	X1	1 KC	to	100 Cycles
	X.1	100 Cycles	to	10 Cycles

Dial Calibration - 1000 divisions per range.

Accuracy - ± 2% except 10 to 100 KC range.

Single Pulse - A push button provides a single pulse at each of the outputs.

External Trigger Input - A positive or negative pulse of 6 volts minimum with a rise time of 2 microseconds will trigger the pulse generator. Another representative figure is 10 volts with 6 microseconds rise time.

POSITIVE SYNC PULSE - Blocking oscillator pulse output through a cathode follower.

Voltage, Open Circuit - At least 20 volts.

Rise Time - .2 microsecond or less.

Width - Approximately .5 microsecond.

Internal Impedance - 470 ohms.

Blocking Condenser - .01 mfd., 500 volts.

POSITIVE DELAYED SYNC PULSE - Blocking oscillator pulse output through a cathode follower separated from POSITIVE SYNC PULSE by approximately 2 microseconds.

Voltage, Open Circuit - At least 12 volts

Rise Time - .2 microsecond or less.

POSITIVE DELAYED SYNC PULSE (continued)

Width - Approximately .5 microsecond.

Internal Impedance - 470 ohm.

POSITIVE SYNC PULSE APPROXIMATELY 1 MICROSECOND BEFORE MAIN PULSE -
Blocking oscillator pulse output through a cathode follower.

Volts, Open Circuit - At least 20 volts

Rise Time - .2 microsecond or less

Width - Approximately .5 microsecond.

Internal Impedance - 470 ohm.

Blocking Condenser - .01 mfd., 500 volts.

POSITIVE PULSE AT LEADING EDGE OF MAIN PULSE -
Blocking oscillator pulse output through a cathode follower, separated from POSITIVE SYNC PULSE APPROXIMATELY 1 MICROSECOND BEFORE MAIN PULSE by a fixed delay line.

Voltage, Open Circuit - At least 15 volts.

Rise Time - Approximately .5 microsecond.

Internal Impedance - 470 ohm.

Blocking Condenser - .01 mfd., 500 volts.

POSITIVE PULSE AT TRAILING EDGE OF MAIN PULSE -
Blocking oscillator pulse from cathode of blocking oscillator.

Voltage, Open Circuit - At least 25 volts.

Rise Time - .2 microsecond or less.

Width - Approximately 1 microsecond or less.

Internal Impedance - 100 ohms. Note: Loading this output will increase the fall time of the main pulse.

Blocking Condenser - .01 mfd., 500 volts.

MAIN PULSE

Width Ranged -

.1	to	1	microsecond
1.0	to	10	microseconds
10.	to	100	microseconds
100.	to	1000	microseconds.

MAIN PULSE (Continued)

Accuracy - ±2%, except 1 microsecond range.

Jitter of Trailing Edge with Respect to Leading Edge - .01% maximum

Effect of Line Voltage - Variations from 105 to 125 volts change the pulse width by .4% maximum.

Dial Calibration - 1000 division per range.

Duty Factor - Limited by the disipation capabilities of the output tube to 25%.

Step Attenuator - Five constant impedance, 93 ohms, Pi sections of 10 db. each in series.

Amplitude Control - 10 db. variable attenuator.

Amplitude - At least 40 volts across a 93 ohm load, internal or external.

Internal Impedance - 93 ohm maximum

Rise Time, 10% to 90% points - .025 microsecond or less.

Fall Time 10% to 90% points - .025 microsecond or less.

Over and Undershoot - Less than 4% with matched load.

Polarity - Plus or minus, but not simultaneously.

Blocking Condenser - None on positive pulses. 125 mfd electrolytic on negative pulses. Maximum external voltage with negative output pulse 0 to 400 volts.

Top of Pulse, Droop - **20% maximum for 1000 us. pulse.**

$$\frac{\%\ \text{Droop}}{100} = \frac{\text{Leading Edge Amplitude} - \text{Trailing Edge Amplitude}}{\text{Leading Edge Amplitude}}$$

INTERNAL DELAY - Measured between the 20% points of the POSITIVE DELAYED SYNC PULSE and MAIN PULSE. When an external trigger is used as a reference the internal delay of the triggering system, approximately 2 microseconds, must be added to the delay reading.

Ranges -			
0	to	1	microsecond
1	to	10	microseconds
10	to	100	microseconds
100	to	1000	microseconds
1000	to	10,000	microseconds

INTERNAL DELAY (Continued)

Jitter - .01% or less.

Accuracy - ±1%, except 1 microsecond range.

Effect of Line Voltage - Variations from 105 to 125 volts change the delay by .4%.

Duty Factor Effects - Minimum recovery time 1½ microseconds.

Error due to high duty factors; representative table for 1000 microsecond range.

Duty Factor	Percent Error
0.5%	0.0 Reference
5	0.1
50	0.4
90	3.2
95	5.0
97	5.5

This does not imply that the error will be the same for all ranges with the same duty factor.

Calibration - 1000 divisions per range.

CONTROLS

On-Off (Power)
Repetition Rate Range and External
Repetition Rate Dial
Single Pulse Switch
Delay Range
Delay Dial
Pulse Width Range
Pulse Width Dial
Main Pulse Polarity Switch
Attenuator Matching Resistor In-Out Switch
Attenuator 10 db. In-Out Switches (5)
Amplitude Control

CONNECTORS

Input and Outputs - S0239 Video Type, may be fitted by customer with UG 273/U adaptors for BNC connectors.

Power Connector - Two Prong Male.

POWER - 110 or 220 volts, 50-60 cycle, 300 watts. Standard units are wired for 110 volt operation.

SIZE - Standard 14" x 19" front panel for rack mounting; supplied with cabinet 14" x 19" x 14", overall depth -- 16". Weight -- 60 lb.

CALIBRATION - Each range of the Oscillator, Delay, and Pulse Width is accurately calibratable by use of separate potentiometer adjustments which change only a D. C. voltage level not involving signals, thus giving non-critical adjustment.

ACCESSORIES SUPPLIED

Six foot (6 ft.) Power Cord.
Four (4) Extension Cables for plug-in chassis.
Instruction Manual.

DESCRIPTION OF FRONT PANEL CONTROLS AND OUTPUTS

ON-OFF SWITCH - Controls A. C. power input.

PILOT LIGHT - INDICATES POWER is being supplied to the instrument.

FUSE - 4 amp. Slo-Blow fuse protection for instrument for 110 volt operation. For 220 volt operation use 2 amp Slo-Blow.

BLOWN FUSE INDICATOR - Indicates, when illuminated, that the fuse is open.

SINGLE SHOT PUSH BUTTON - PRODUCES a step function which triggers the generator once each time operated. Use ONLY when FREQUENCY RANGE SWITCH is in the External position and the ± EXTERNAL TRIGGER SELECTOR SWITCH is in the + position.

FREQUENCY RANGE SWITCH - Switches condensers in the repetition rate oscillator to give decade frequency ranges.

FREQUENCY - Helical potentiometer which changes the potential of the grid return in the Oscillator to give a continuously variable frequency. Determines pulse period along with FREQUENCY RANGE SWITCH. Frequency in cycles per second.

TRIGGER, EXTERNAL JACK - External Trigger Input, to be used ONLY when FREQUENCY RANGE SWITCH is in the External position.

POSITIVE SYNC PULSE - Blocking Oscillator pulse, to be used as a reference pulse.

POSITIVE DELAYED SYNC PULSE - POSITIVE SYNC PULSE delayed approximately 2 microseconds by a fixed delay line, to be used as a reference pulse. The calibrated Internal Delay is with reference to this pulse.

DESCRIPTION OF FRONT PANEL CONTROLS AND OUTPUTS (continued)

DELAY RANGE SWITCH - Determines the delay range in microseconds of the main pulse with respect to the delayed sync pulse by switching the Miller Integrator constants.

DELAY - Helical Potentiometer which varies the D.C. comparator voltage to give a continuously variable delay.

POSITIVE PULSE APPROXIMATELY 1 MICROSECOND BEFORE LEADING EDGE OF MAIN PULSE - Blocking Oscillator pulse which moves with the main pulse and precedes the main pulse by approximately 1 microsecond, to be used as a triggering pulse.

POSITIVE PULSE AT LEADING EDGE OF MAIN PULSE - Blocking Oscillator pulse that moves with the main pulse and occurs at the time of the leading edge of the main pulse.

PULSE WIDTH RANGE - Determines the pulse width range in microseconds by switching the Miller Integrator constants.

PULSE WIDTH - Helical Potentiometer which varies the D. C. comparator voltage to produce a continuously variable width pulse calibrated in microseconds.

MAIN PULSE - Variable width, variable delay, variable amplitude pulse of either positive or negative polarity. Maximum output impedance--93 ohms.

MAIN PULSE ± SWITCH - Switches resistors in the output tube circuit to obtain positive or negative pulses.

AMPLITUDE CONTROL - Fill in amplitude control which varies amplitude at least 10 db.

STEP ATTENUATOR, EACH SWITCH - Cuts in or out at constant impedance Pi section with an attenuation of 10 db per section. Total attenuation is obtained by adding together the attenuation of sections "IN".

TERMINATING RESISTOR - Switches in or out a 93 ohm resistor to terminate the PULSE GENERATOR, should be "IN" when high impedance load is used and should be "OUT" when 93 ohm load is used.

OPERATING INSTRUCTIONS

The following sequence is suggested in placing the instrument in operation for the first time.

1. Turn the power switch on.

2. Place the Frequency Range Switch in the X10 position and the FREQUENCY DIAL in the 100 position. The repetition rate period is:

$$\frac{1}{1000 \text{ cps.}} = .001 \text{ second or } 1000 \text{ microseconds.}$$

3. Trigger the Synchroscope sweep from the Positive Synchronizing Pulse.

4. Set the DELAY RANGE SWITCH to the 100 microsecond range.

5. Set the PULSE WIDTH RANGE SWITCH to the 100 microsecond range.

The variable delay with resepct to the POSITIVE SYNC PULSE and the variable pulse width can be observed as functions of the DELAY and PULSE WIDTH dial settings.

> **N O T E**
>
> The maximum pulse width is limited to approximately 25% of the repetition rate period. (See the section on LIMITATIONS OF PULSE GENERATOR.)

To obtain the best possible wave shape from the output it is imperative that a matching load be applied at the end of the transmission line. For instance, if an unterminated cable is connected to the output, the wave shape will have considerable overshoot and undershoot. The matching resistor in the attenuator will not serve to remove this overshoot since the mismatch is at the other end of the cable. The use of 93 ohm co-acial cable is recommended, and when properly terminated with the MATCHING RESISTOR "OUT" provides the proper load for the five 10 db. step attenuators.

PRINCIPLES OF OPERATION

EXPLANATION ON BASIS OF SIMPLIFIED BLOCK AND TIMING DIAGRAM (B2-A-1115)

A Phantastron oscillator or external trigger determines the repetition rate of all of the outputs of the B-2 PULSE GENERATOR. The output of the oscillator or trigger amplifier is fed into the shaping circuit; the outputs are the negative pulse to the delay circuit, the SYNC PULSE (1), and DELAYED SYNC PULSE (2). The outputs of the delay are a positive pulse to the pulse forming circuit, a negative pulse

to the pulse width circuit, the PULSE APPROX. 1 MICROSECOND BEFORE LEADING EDGE OF MAIN PULSE (3), and the PULSE AT LEADING EDGE OF MAIN PULSE (4). The output of the pulse width circuit is a positive pulse to the pulse forming circuit. The outputs of the pulse forming circuit are the PULSE AT TRAILING EDGE OF MAIN PULSE (5) and the MAIN PULSE (6 or 7).

For internal operation a double Phantastron oscillator is used as the frequency source. The complex plate wave from a cathode follower is differentiated and the positive pulse used to trigger the blocking oscillator. For external operation a cathode coupled amplifier is employed, and its positive output pulse is used to trigger the blocking oscillator. The single pulse switch provides a positive trigger at the input to the cathode coupled amplifier for single shot operation. The positive output of the blocking oscillator is fed to a cathode follower, the output of which is the SYNC PULSE output, and to a 2 microsecond delay line. The delayed output of the line is fed to another cathode follower and thence, to the DELAYED SYNC PULSE output. A negative pulse from the blocking oscillator is used to start the DELAY CHASSIS circuits.

All of the above mentioned operations take place physically in the SYNC-FREQUENCY CHASSISand associated front panel controls.

The negative blocking oscillator pulse from the SYNC-FREQUENCY CHASSIS triggers the flip-flop in the DELAY CHASSIS which gates on the Miller integrator, starting the negative going triangular wave. The negative going voltage is applied to one grid of the comparator, while the output of the helical potentiometer is applied to the other grid. When both voltages are approximately equal a negative pulse is formed by the comparator, which, after being amplified, triggers a blocking oscillator. A negative pulse from the blocking oscillator is used within the DELAY CHASSIS to retrigger the flip-flop, and hence, reset the delay circuits, readying them for another input pulse from the SYNC-FRE* quency chassis. The negative pulse from the blocking oscillator is also used to trigger the flip-flop of an identical circuit which determines the width of the main pulse. A positive pulse from the blocking oscillator is applied to a cathode follower and to a fixed delay line. The output of the cathode follower is fed to a jack on the front panel and is the POSITIVE PULSE APPROXIMATELY 1 MICROSECOND BEFORE LEADING EDGE OF MAIN PULSE. The output of the delay line goes to the PULSE FORMING CHASSIS and to another cathode follower which supplies the POSITIVE PULSE AT THE LEADING EDGE OF THE MAIN PULSE..

As mentioned before, the PULSE WIDTH CHASSIS is the same in all respects as the DELAY CHASSIS; however, in

addition to the blocking oscillator output, a negative gate from the flip-flop is taken as an output into the PULSE FORMING CHASSIS.

In the PULSE FORMING CHASSIS the discharge tubes are biased well below cut-off while the clamp tube is biased at zero volts and hence maintains the charge on the pulse forming condensor, "C", at zero between pulses. The negative gate from the PULSE WIDTH CHASSIS gates off the clamp tube and readys "C" to receive the charging current pulse. About one microsecond later, the positive pulse from the delay line triggers the input blocking oscillator, which in turn triggers the pulse forming blocking oscillator charging "C" to a positive voltage. The cathode follower couples the charge on "C" to the output tube grid. The pulse from the PULSE WIDTH CHASSIS triggers the trailing edge blocking oscillator which applies a positive pulse to the grids of the discharge tubes. One of the discharge tubes draws current from "C" returning it to zero volts while the other discharge tube discharges the stray capacitance of the output tube grid circuit. The main pulse is taken from the cathode or plate of the output tube for positive and negative pulses respectively and is passed through the constant impedance attenuator to the front panel output jack.

The REGULATOR CHASSIS provides the necessary regulated v voltages.

CIRCUIT DESCRIPTION

The Schematic (B2-N-1130) shows the combined circuitry and should be referred to in the following discussion.

FREQUENCY - SYNCHRONIZING CHASSIS

A double cathode coupled phantastron oscillator is used to give the greatest timing accuracy available with a high degree of linearity. The timing is determined on both halves of the cycle by a linear waveform. To explain this circuit, let us consider only half of the circuit consisting of V-101 and V-106a. If a negative voltage is applied to the suppressor grid of V-101, the plate current will be shut-off and the plate voltage will rise to the supply voltage. Since the grid return voltage is positive, the screen will conduct heavily, causing the cathode voltage to rise. Now, if the suppressor voltage is raised to a value permitting the plate to conduct, the plate voltage will start to drop. This drop is coupled through the cathode follower (V-106a) and C-801, 803, 805, or 807 to the grid of V-101, and as soon as the grid reaches a voltage near cut-Off, the rapid plate voltage fall will be replaced with a Miller run down. During this Miller action, the grid will remain near cut-off; hence, the cathode current will be small and very little voltage will be developed across the cathode resistor. As soon as the plate bottoms-- reaches a voltage below which it can not go-- the grid voltage will

begin to rise and the cathode will follow. To sum up the important points, a negative voltage on the suppressor grid caused the plate to go positive, the screen to draw current, and a positive voltage to be developed across the cathode resistor. A positive voltage on the suppressor caused a Miller run down and very little voltage across the cathode resistor until the plate bottomed, when the cathode voltage began to rise. Now, to put the two halves together, suppose that V102's plate is cut-off by its suppressor while V 101's in the Miller run down part of its cycle. As soon as the plate of V-101 bottoms, the cathode starts to rise; this is the voltage we need to start the Miller action in V-102; also as soon as the Miller action starts, V-102's cathode voltage drops and this is the voltage we need to cut-off the plate of V-101. Cross coupling from the cathodes to the suppressor grids of V-101 and V-102 will, therefore, give an oscillator with a period equal to the sum of the run down times of the two tubes. The run down time is proportional to the size of the plate to grid coupling condensors and inversly proportional to the grid return voltage. In this circuit the range is determined by switching the condensors and the fine frequency is determined by grid return voltage as determined by the helical potentiometer.

The complex plate waveshape is taken from the cathode follower (V-106b) and differentiated; the resulting pulses are applied to the trigger tube of the blocking oscillator, V-104. The negative pulse from the plate of the blocking oscillator triggers the flip-flop used in the following delay circuits. The positive pulse from the cathode of the blocking oscillator provides, through a cathode follower, the POSITIVE SYNC PULSE and, through a 2 microsecond delay line and cathode follower, the POSITIVE DELAYED SYNC PULSE. Delaying the synchronizing pulse permits calibrating delays down to zero microseconds.

For external triggering, a cathode coupled amplifier is used so that input pulses of either polarity can be accepted. The positive output of the amplifier is coupled into the trigger tube of the above mentioned blocking oscillator through the differentiating network. For single shot operation a push button applies a positive going voltage to the input of the cathode coupled amplifier.

IMPORTANT
FOR SINGLE SHOT OPERATION, THE FREQUENCY RANGE SWITCH MUST BE ON EXTERNAL, AND THE EXTERNAL ± SWITCH MUST BE ON +

DELAY CHASSIS

The delay system used consists of four major units -- Flip-flop, screen coupled Miller integrator, comparator, and trigger forming blocking oscillator.

DELAY CHASSIS (continued)

The delay system works as follows. Initially, the pin 1 plate of V201 is conducting fully and is at approximately - 35 volts. This is sufficient to cut-off plate current. The clamping diode, V-202a, assures that the plate of V-203 will start at + 225 volts. The comparator, V-204, is such that the left hand side is conducting at constant current due to V-205a, and the right hand side is below cut-off at a voltage determined by the helical potentiometer setting. The negative pulse from the SYNC-FREQUENCY CHASSIS triggers the flip-flop, V-201, causing the pin 1 plate to go positive gating on the screen grid of the Miller tube. This circuit acts in just the manner previously described in the oscillator section, and a very linear triangle results at the plate. This negative triangle is coupled to the comparator grid, pin 2. The left hand side of V-204 acts as a cathode follower and the negative triangle will eventually run into the grid base of the right hand side of V-204. The constant current, flowing in V-205a, now shifts regeneratively to the right hand side, causing the RLC load in the plate to ring. After the first half of the oscillation, the diode clamps out the positive going pulse and a negative spike is left to be amplified in V-205b and then trigger the blocking oscillator V-206. The blocking oscillator pulse now retriggers the flip-flop to ready it for the next cycle. A number of advantages are obtained by use of this curcuit. The two most important are given below:

(1). The delay duty cycle is limited only by the recharging time of the delay condenser which is recharged via the cathode follower, one half of V-204.

(2). Very fast delay ranges can be obtained; since the only limitations are on how fast the Miller tube can be gated and how much grid current the Miller tube is capable of drawing.

PULSE WIDTH CHASSIS

The pulse width delay circuitry is a duplication of the delay circuit described above.

PULSE FORMING CHASSIS

Initially the charge on C-305 is zero as determined by the clamp tube, V-304. About 1 microsecond before the start pulse, a negative gate is applied to the grid of the clamp tube, cutting it off and readying C-305 to receive a charge. The start pulse triggers a blocking oscillator which, in turn, triggers the pulse forming blocking oscillator, V-302, which charges C-305 to about 200 volts. This charge is coupled to

PULSE FORMING CHASSIS (continued)

to the output tube, V-307 by the cathode follower, V-303a. The stop pulse triggers the blocking oscillator, V-306, which applies a very positive voltage to the grids of the discharge tubes causing them to draw current. The current through discharge tube V-305, returns the charge on C-305 to zero while the discharge tube V-303b, discharges any stray capacitance in the output tube grid circuit. The diode, V-308, provides D.C. restoration so that the base of the pulse coupled through via C-312 will also start from the same level, as determined by the amplitude control potentiometer, R-814. The output tube, V-307, is a 3E29, which is used as a cathode follower or inverting amplifier.

The attenuator is a constant impedance, 93 ohm, Pi network with five (5) sections of 10 db. each, for a total attenuation of 50 db. The variable amplitude is obtained by varying the DC restoration voltage on the 3E29 tube.

REGULATOR

The regulators used are of the convential series tube, negative feed back type which use as their reference a 5651 voltage regerence tube, V-401. The four regulated voltages obtained are - 150, +225, +400, and a doubly regulated +225.

Selenium rectifiers are used to keep heat dissipation to a minimum.

LIMITATIONS OF THE B-2 PULSE GENERATOR

PULSE WIDTH

Pulse width is limited by the capabilities of the 3E29 tube. Operation of this tube under the conditions in this equipment indicates that a 25% duty factor is about its limit. Cathode sagging -- i.e. with a perfectly square grid pulse the cathode voltage sags as if a coupling condenser were too small-- and the availability of high capacity condensers needed to couple wide pulses into a 93 ohm load limits the maximum pulse width to about 1000 microseconds.

PULSE DELAY

Pulse delay is limited to approximately 90% duty factor (varies with delay range) by the recharging time of the triangle generator and several small inherent delays of the triggering circuits.

MAINTENANCE AND ADJUSTMENT

REMOVAL OF CABINET

Remove the eight (8) screws holding the front panel to the cabinet. Remove the 115 volt power plug and pull unit from cabinet by the front panel handles.

REMOVAL OF PLUG-IN UNITS

Turn the B-2 PULSE GENERATOR on its side so that the bottom is available. Turn the "DZUS" fastener on the desired unit counterclockwise and hold away from the chassis while pulling the plug-in unit out toward the back of the instrument.

CLEANING

The air filter must be kept clean to provide adequate coolingof the instrument. A washable filter is used. The following filter cleaning instructions are given by the filter manufacturer.

" To Clean:

(1) If grease or dirt load is light, remove filter from installation and flush dirt or grease out of filter with a stream of hot water or steam.

(2) If load is too heavy for treatment in (1) above, prepare mild soap or detergent solution in pan or sink deep enough to cover filter when laid flat. Agitate filter up and down in this solution until grease or dirt is loosened and carried off filter.

(3). Rinse filter and let dry.

(4) Dip or spray filter with fresh Filter Coat, or other approved adhesive. Filter Coat is available from the local representative of RESEARCH PRODUCTS CORP., in the one-pint Handi-Koter with spray attachment or one-gallon and five-gallon containers.

At regular intervals, any dust that should settle on the interior of the instrument should be removed by means of dry compressed air. Avoid a high velocity air stream which might injure the instrument or disturb adjustments. Persistent dirt may be removed with a lint free cloth and, if necessary, carbon tetrachloride.

Under normal conditons, the silver plated contacts of the rotary switches should not require special attention. In case they become tarnished, the contacts should be cleaned by rotating the switch several times.

INSPECTION

A visual inspection is desirable while the B-2A PULSE GENERATOR is being cleaned.

Switches - Turn the rotary switches while observing the contacts to check contact centering in each index position. Improperly centered contacts may be due to the switch becoming warped or twisted. AVOID pressure on the contacts as

they are easily damaged.

Capacitors and Resistors - Inspect the electrolytic capacitors for leakage of electrolyte, replacing if necessary. The wax coating of paper tubular capacitors may drip if the instrument has been overheated by operating in a restricted space or with a dirty air filter. This condition usually does not indicate replacement. Composition resistors should be checked for serious discoloration which would indicate excessive dissipation and, therefore, faulty operation. A moderate amount of discoloration is normal.

Connections - Loose screws or nuts should be tightened. This is especially important when the screw serves as an electrical connector. Corrosion of the chassis and electronic components is unlikely under normal conditions. Corrosion should be removed, if evident, and the cause corrected. If the instrument must be used in a corrosive atmosphere, it may be desirable to remove the tubes occasionally and clean the contact pins with crocus cloth. Then remove and insert the tubes several times to clean socket contacts.

TROUBLE SHOOTING AND REPAIR

It is important that the operation, circuit theory, and physical location of components be thoroughly understood before repair of the model B2 PULSE GENERATOR is undertaken. If the Circuit Description and Schematic Diagram are carefully studied, most defects will be found relatively easy to locate.

C A U T I O N

Be sure to check the setting & adjustment of the controls before attempting to repair to verify that the difficulty is actual.

Although tables of average voltage and resistance values are included to facilitate servicing, they should be used for reference ONLY, and ARE NOT meant to serve as a "Check List" or sequence chart for circuit testing. This system might eventually lead to the trouble, but the isolation or signal tracing methods are usually much faster.

Since a large percentage of troubles experienced with electronic equipment is caused by defective tubes, it is advisable to check the tubes in suspected circuits prior to conducting extensive tests of other components.

CALIBRATION

It is recommended that at least thirty (30) minutes warm-up preceed any calibration. All calibration adjustments for Frequency, Delay, and Pulse Width are located together on the right hand side panel, facing the front panel.

Frequency - Rough frequency calibration should be made by comparison at the beginning of, for example, the leading edge of the main pulse to the leading edge of the main pulse on the next cycle with the calibration of the synchroscope. This would give an approximate accuracy of ten percent (10%).

Fine calibration should be made with reference to a crystal osillator. It is recommended that this be done with a pulse type calibrator, such as the RUTHERFORD ELECTRONICS CO. model D-2 CALIBRATOR. Suggested procedure for calibrating the 100 KC range is as follows:

Synchronize the sweep circuits of the synchroscope from the Model D-2 CALIBRATOR, using the 100 KC (10 us.) blocking oscillator output. In general the pulse will move, either to the right or to the left, showing that the frequency is not identical to the standard. The helical potentiometer dial should be set to read 1000. Potentiometer #1 is nowturned until the pulse which is observed has stopped moving in either direction. The helical potentiometer is now turned to read 100; the 10 KC trigger from the CALIBRATOR is used to start the synchroscope sweep, and potentiometer No. 5 is used to stop the observed pulse from moving. Check the 100 KC again; since, moving the lower potentiometer causes the upper one to change slightly. This is, however, a converging process, and calibration to any required degree can be obtained. Calibration of the other ranges is a repetition of the above procedure.

The universal electronic timer and counter can also be used for these adjustments, and when available is desired.

Delay - The delay is calibrated by comparison with a signal of known accuracy through the medium of a synchroscope. For the one microsecond range the synchroscope is calibrated from the standard signal so that the sweep covers the width of the graticule in one microsecond. The synchroscope is then triggered from the DELAYED POSITIVE SYNC PULSE. The synchroscope input is then connected to the DELAYED POSITIVE SYNC PULSE and the horizontal position control adjusted so that the 20% point (or any other point) of the sync pulse coincides with the left edge of the graticule. Then with the dial set at 1000 the lower delay potentiometer (No. 16) is adjusted so that the 20% point of the MAIN PULSE coincides with the right edge of the graticule.

CALIBRATION - CONTINUED

The zero delay should then be readjusted and then again the one microsecond setting since there is interaction between the controls; however, this is a converging process and the required accuracy is reached with but a few adjustments of the upper and lower potentiometers. The 10, 100, 1000, and 10,000 microsecond ranges are calibrated in the same manner except that the upper potentiometers are adjusted for a one-tenth full scale setting of the helical potentiometer instead of zero. This necessitates calibrating the synchroscope for both the one-tenth and full scale settings of each range.

The electronic timer can be used for these adjustments and where available is desirable.

Pulse Width - The Pulse Width is calibrated the same way as the delay except that the one microsecond range is calibrated at two-tenths (2/10) full scale instead of at zero. The width of the output pulse can be observed on the calibrated sweep of the synchroscope using the internal trigger this reduces the required switching in calibrating the synchroscope.

VOLTAGE AND CONTINUITY TABLES

C A U T I O N - The potentials and resistances listed in these tables are average values. Many of them will exhibit considerable normal variation with different individual instruments due to manufacturing tolerances of the components and tube characteristics. Therefore, these tables should be used only in conjunction with careful study of the Circuit Description and Maintenance sections and the Schematic Diagram.

Unless otherwise specified, the readings were taken with the tubes in their sockets and controls set as follows:

FREQUENCY RANGE	- EXTERNAL
DELAY RANGE	- 1 microsecond
PULSE WIDTH RANGE	- 1 microsecond

A DC voltmeter of 20,000 ohms per volt sensitivity was used for all DC voltage measurements. All voltages DC, measured with respect to ground, and positive unless otherwise stated and all plug-in units in main chassis.

Frequency-Sync Chassis

Tube	Pin	Voltage	Resistance	Notes
V-101	1	0	infin.	
6AS6	2	30	5K	
	3	gnd.		
	4	6.3AC		
	5	47	50K	
	6	150	16K	
	7	30	5.K	
V-102				Same as V-101
6AS6				
V-103	1	180	15K	
12AT7	2	0	1M	
	3-8	.5	12K	
	4-5	6.3AC		
	6	170	15K	
	7-9	gnd.		
V-104	1-6	225	11K	
12aT7	2	-10	20K	
	3-9	gnd.		
	4-5	6.3AC		
	7	6.6	14K	
	8	0	370ohm	
V-105	1-6	225	11K	
12AU7	2	0	370ohm	
	3	7	1000ohm	
	4-5	6.3AC		
	7	0	600ohm	
	8	7	1000ohm	
	9	gnd.		
V-106	1-6	225	11K	
12AU7	2	48	60K	
V-106	3	54	10K	
Cont.	4-5	6.3AC		
	7	48	60K	
	8	54	10K	
	9	gnd.		

Delay and Pulse Width

Tube	Pin	Voltages	Resistance	Notes
V-201	1	-100	15K	
5687	2	-110	10K	
	3-6	-110	5K	
	4-5	gnd		
	7	-130	11K	
	8	6.3AC		
	9	75	15K	
V-202	1	225	35K	
6AL5	2	-100	15K	
	3	225	10K	6.3AC with respect to pin #4
	4	225	10K	6.3AC with respect to pin 3
	5	70	60K	
	6	gnd		

Delay and Pulse Width (continued)

Tube	Pin	Voltage	Resistance	Notes
6AL5	7	225	200K	
V-203	1	225	200K	
5763	2			N.C.
	3-4-7	gnd.		
	5	6.3AC		
	6	-100	15K	
	8-9	2.3	180K	
V-204	1	350	200K	
12AU7	2	225	200K	
	3-8	227	infin.	
	4-5	225	10K	6.3AC with respect to pin 9
	6	400	100K	
	7	100	80K	
	9	225	10K	6.3AC with respect to pins 4-5
V-205	1	227	infin.	
12AU7	2-3-9	gnd.		
	3	7.4	20K	
	4-5	6.3AC		
	6	95	13K	
	7	.15	2M	
V-206	1-6	225	10K	
12AU7	2	-36	18K	
	3-9	gnd.		
	4-5	6.3AC		
	7	-24	11K	
	8	0	350ohm	
V-207	1-5	80	60K	
6AL5	2	-100	14K	
	3	225	10K	6.3AC with respect to pin 4
	4	225	10K	6.3AC with respect to pin 3
	6	gnd.		
	7	80	14K	

Pulse Forming

Tube	Pin	Voltage	Resistance	Notes
V-301	1-8	400	130K	
12AT7	2	-20	14K	
V-301	3-9	gnd.		
cont.	4-5	6.3AC		
	7	-25	5.5K	
	8	0	1K	
V-302	1-2	400	180K	
5964	3	gnd.		
	4	6.3AC		
	5-6	-25	5.5K	
	7	0	22M	
V-303	1	400	180K	
12BH7	2	0	22M	
	3	35	100K	
	4-5	6.3AC		
	6	35	100K	
	7	-20	3K	
	8-9	gnd		
V-304	1	-.65	2M	
6AU6	2-3-9	gnd		

Pulse Forming (continued)

Tube	Pin	Voltage	Resistance	Notes
6AU6 cont	4	6.3AC		
	5-6	0	22M	
V-305 6AU6	1	-20	3K	
	2-3-7	gnd.		
	4	6.3AC		
	5-6	0	22M	
V-306 12BH7	1-6	400	180K	
	2	-45	10K	
	3	0	1K	
	4-5	6.3AC		
	7	-25	11K	
	8-9	gnd		
V-307 3E29	1	6.3AC		
	2	-140	430K	
	3	400	180K	
	4	0	93ohm	Main pulse switch in pos. N.C.
	5			
	6	-140	430K	
	7	6.3AC		
	Plates	400	50K	
V-308 6AL5	1-5	-140	430K	)Depends on setting of
	2-7	-150	4K	)Amplitude Control.
	3	6.3AC		
	4	gnd		
	6			N.C.

Regulator

Tube	Pin	Voltage	Resistance	Notes
V-401 5651	1-5	-65	20K	
	2-7	-150	3.3K	
	3-4-6			N.C.
V-402 6AU6	1	-65	200K	
	2-7	-150	20K	
	3-6	gnd		
	4	6.3		
	5	-35	1.1M	
V-403 6AU6	1	-4	100K	
	2-3-7	gnd		
	4	6.3AC		
	5	150	1.2M	
	6	125	70K	
V-404 6AU6	1	-5	100K	
	2-3-7	gnd		
	4	6.3AC		
	5	400	850K	
	6	160	100K	
V-406 6AU6	1	-3.5	100K	
	2-3-7	gnd		
	4	6.3AC		
	5	205	1.1M	
	6	125	80K	
V-407 12BH7	1	400	180K	
	2	205	1.1M	
	3	215	36K	
4-5			10K	6.3AC with respect to pi n 9

Regulator (continued)

Tube	Pin	Voltage	Resistance	Notes
	6-7-8			Not Used
	9		10K	6.3AC with respect to pins 4-5
V-408	1	400	180K	
12B4	2-7	390	1M	
	3	225	10K	6.3AC with respect to pins 4-5
	4-5	225	10K	6.3AC with respect to pin 3
	6-8			N. C.
	9	560	60K	
V-409				Same as V-408
12B4				

Main Chassis

Tube	Pin	Voltage	Resistance	Notes
V-701	1-6	225		
12AU7	2	0		
	3	7		
	4-5	6.3AC		
	7	0		
	8	7		
	9	gnd.		
V-702	1	150		
6AS7	2	95		
	3	43		
	4	-30		
	5	90		
	6-7	gnd.		
	8	6.3AC		

Transformer

Terminals	Voltage AC	Resistance
1 to 3	110	.17
2 to 4	110	.17
5 to 6	6.3	.1
6 to 7	6.3	.1
5 to 7	12.6	.2
8 to 9	3.15	.05
9 to 10	3.15	.05
8 to 10	6.3	.1
11 to 12	160	44
12 to 13	160	44
11 to 13	320	88
14 to 15	202	36
15 to 16	202	36
14 to 16	404	72
17 to 18	300	32
18 to 19	300	32
17 to 19	600	64
20 to 21	286	30
21 to 22	286	30
20 to 22	572	60

I M P O R T A N T

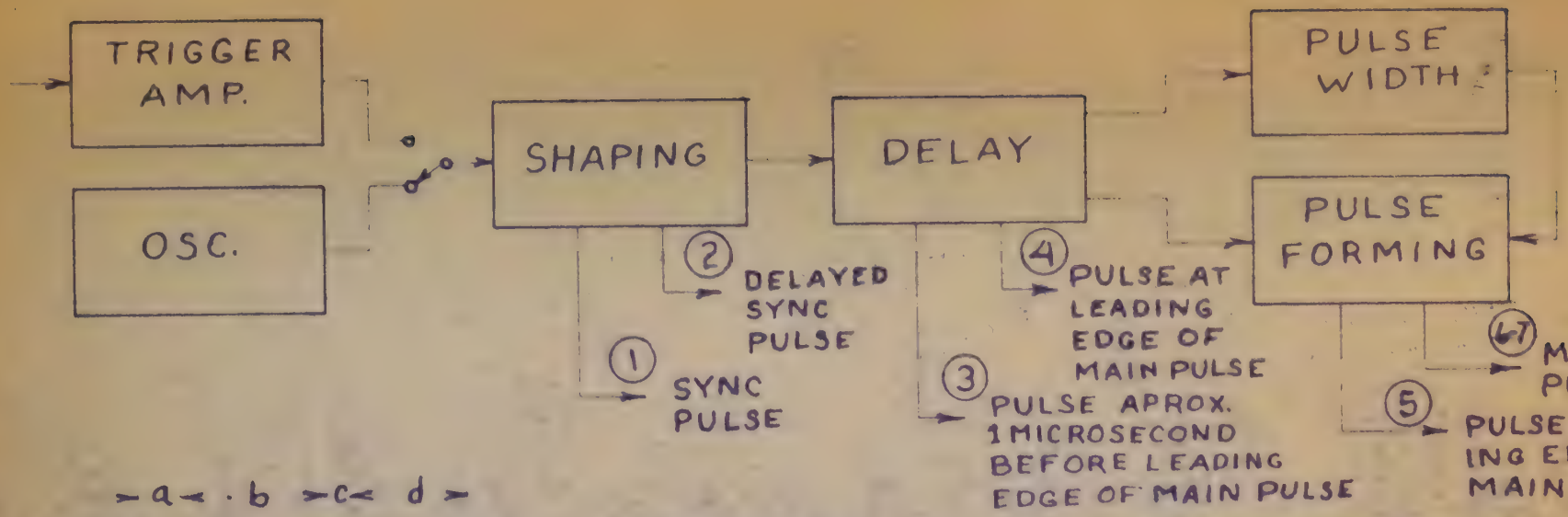
B e sure to include the INSTRUMENT MODEL and SERIAL NUMBER in all correspondence regarding any Rutherford instrument. The serial number will be found near the power input plug on Model B-2 PULSE GENERATORS.

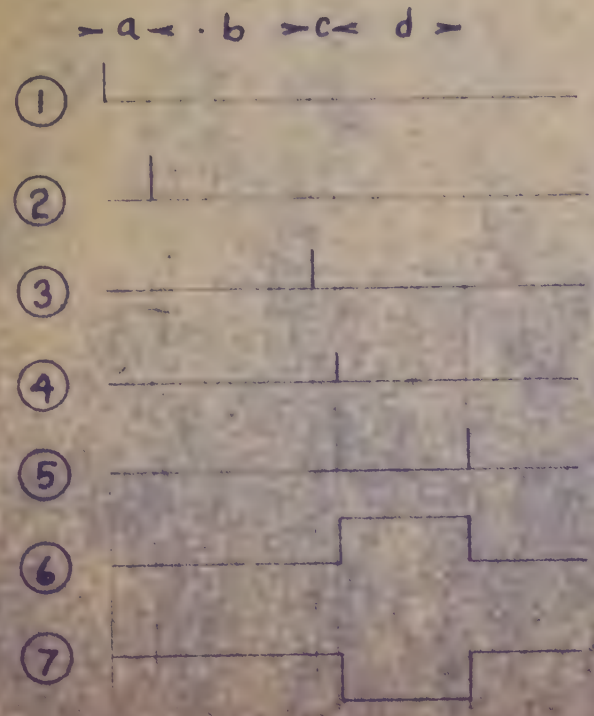
WARRANTY

Rutherford ELECTRONICS CO., guarantees to the original purchaser for a period of one year, EXCEPT vacuum tubes which are guaranteed for ninety day, that the Model B-2 PULSE GENERATOR is free from defects in material and workmanship. Our liability is limited to repair or replacement of this instrument, or any part thereof, providing failure is not due to misuse or abnormal conditions.

In order to receive service under this warranty, promptly advise the factory of all details pertinent to failure of the instrument. Replacement parts will be shipped, via air transportation if requested, prepaid to any point in the continental United States, Should it be desirable to return the instrument, ship it prepaid to the factory, and it will be serviced as required and returned via surface transportation.

Service required after the expiration of warranty, or because of misuse or abnormal conditions will be billed at cost.




a
b
c
d
1 SYNC PULSE
2 DELAYED SYNC PULSE
3 PULSE APROX. 1 MICRO-SECOND BEFORE LEAD-ING EDGE OF MAIN PULSE
4 PULSE AT LEADING EDGE OF MAIN PULSE
5 PULSE AT TRAILING EDGE OF MAIN PULSE
6 MAIN PULSE (POSITIVE)
7 MAIN PULSE (NEGATIVE)

DISCRIPTION

a FIXED BY DELAY LINE APROX. 2 MICROSECONDS

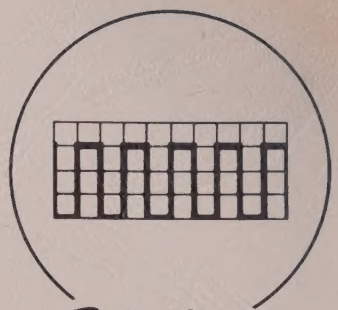
b CONTROLLED BY DELAY RANGE SWITCH AND POTENTIOMETER

c FIXED BY DELAY LINE APROX. 1 MICROSECOND

d CONTROLLED BY PULSE WIDTH RANGE SWITCH AND POTENTIOMETER

SIMPLIFIED BLOCK & TIMING DIAGRAM

B2-A-1115



Rutherford

ELECTRONICS CO.

Printed in U.S.A.